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Polarization studies at soft x-ray wavelengths

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Multilayer x-ray interference structures function as linear polarizers and phase retarders over a broad range, extending roughly from 50 to 900 eV, which includes core resonances of numerous elements. The broad interference peaks of multilayers, compared to crystals, enables their easy incorporation into polarization-sensitive instrumentation. Their synthetic nature allows for production of laterally graded structures that can function as continuously tunable linear polarizers. A tunable polarimeter based on multilayers and utilizing these features will be described, as will some of its early uses, which fall into three categories: beamline characterization, polarizing optics development, and polarization-sensitive materials studies. With this spectro-polarimeter, we have extended magneto-optical rotation techniques commonly used in the visible range into the soft x-ray region to the $L_{2,3}$ edges of the 3d ferromagnetic elements. At core resonances, not only are magneto-optical rotation techniques element-specific, but the effects can be larger than in the visible range because of the selective dipole excitation to the 3d states responsible for magnetism. Element-specific magnetic hysteresis loops from sputtered Fe/Cr multilayers (which exhibit the giant magneto-resistance effect) have been obtained.